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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/558,053	04/26/2000	Hisako Apyama	0039-7684-2 SRD DIV	9571

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EXAMINER

MALDONADO, JULIO J

ART UNIT

PAPER NUMBER

2823

DATE MAILED: 08/30/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/558,053

Applicant(s)

APYAMA ET AL.

Examiner

Julio J. Maldonado

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 June 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 29-33 and 35-40 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 29-33 and 35-40 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claim 29-33, 36, and 37 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al. (U.S. 4,789,648) in view of Mu et al. (U.S. 5,612,254) and Koerner et al. (U.S. 5,478,780).

In reference to claim 29, Chow et al. in a related method to form an interconnect structure teach the steps of forming a first insulating film (5) on a semiconductor substrate (2); forming a second insulating film (6) on said first insulating film (5), said second insulating film (6) being made of a material different from that of the first insulating film (5) and having a thickness smaller than that of the first insulating film (5); forming a third insulating film (8) on said second insulating film (6), said third insulating film (8) being made of a material different from that of the second insulating film (6) and having a thickness larger than that of the second insulating film (6); forming a groove (7) in a region of said third insulating film (8), in which a wiring is to be formed, said groove having a bottom to which said second insulating film (6) is exposed; removing a part of that portion of the second insulating film (6) which is exposed to the groove (7), and part of the first insulating film (5) under the portion of the second insulating film (8), and thus a contact hole reaching to the semiconductor substrate (2); and burying the groove (7)

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and the contact hole with a copper alloy (9) to form a wiring in said groove (7) and a contact in said contact hole (column 2, line 67 – column 4, line 35).

Chow et al. fail to teach the step of removing the second and first insulating film using the same etching mask. However, Mu et al. (Figs.2-8) in a related method to form copper interconnects in a semiconductor substrate teach the step of removing a portion of the second insulating film (23) and of the first insulating film (22) under said portion of second insulating film (23) using the same etching mask, and thus forming a contact hole reaching to the semiconductor substrate (20) (column 6, lines 8–15). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to remove the second and first insulating film using the same mask as taught by Mu in the interconnect formation method of Chow et al., since the removal of multiple layers in one step would simplify the processing (column 6, lines 8-15).

Still, the combination of Chow et al. and Mu et al. fail to teach the step of controlling the deposition of copper to avoid formation of a native oxide. However, Koerner et al. (Fig.3) in a related method to form copper interconnects teach the step of controlling the deposition of a copper layer (22) to avoid formation of a native oxide (column 9, lines 13-20). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to control the deposition of copper to avoid the formation of native oxides as taught by Koerner et al. in the combined method of Chow et al. and Mu et al., since by preventing the formation of oxides, the contact resistance would be reduced and the adhesion of the individual layers would be improved (column 3, line 56 – column 4, line 10).

In reference to claims 30-34, 36 and 37, the combined method of Chow et al., Mu et al. and Koerner et al. teach that the first and third insulating films are substantially SiO_2 and that the second insulating film is formed of Si_3N_4 ; forming a Nb barrier film; depositing a carbon film on the third insulating film; forming a metal wiring of Al or Cu; and forming another Nb barrier layer on said metal barrier (Mu et al., column 4, lines 38-55 and column 8, lines 39-67).

3. Claims 35, 38 and 39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al. ('648) in view of Mu et al. ('254) and Koerner et al. ('780) as applied to claims 29-33, 36, and 37 above, and further in view of Roth et al. (U.S. 5,272,117).

In reference to claim 35, Chow et al. in combination with Mu et al. and Koerner et al. substantially teach all aspects of the invention but fail to teach depositing a layer of dielectric material comprising carbon, which acts as an etch-stop layer. However, Roth et al. (Figs.1-11) in a related method to form planarized interconnects teach forming an etch-stop layer (18) formed of carbon (column 3, lines 51-62). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to include a carbon layer as an etch-stop layer as taught by Roth et al. into the interconnect formation method of Chow et al., Mu et al. and Koerner et al., since this would protect the underlying layers from over-etching (column 3, lines 39-62).

In reference to claims 38 and 39, the combined teachings of Chow et al., Mu et al., Koerner et al. and Roth et al. teach forming another Nb barrier layer on said metal barrier (Mu et al., column 4, lines 38-55 and column 8, lines 39-67).

4. Claim 40 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chow et al ('648) in view of Koerner et al. ('478).

Chow et al. in a related method to form an interconnect structure teach the steps of forming a first insulating film (5) on a semiconductor substrate (2); forming a second insulating film (6) on said first insulating film (5), said second insulating film (6) being made of a material different from that of the first insulating film (5) and having a thickness smaller than that of the first insulating film (5); forming a third insulating film (8) on said second insulating film (6), said third insulating film (8) being made of a material different from that of the second insulating film (6) and having a thickness larger than that of the second insulating film (6); forming a groove (7) in a region of said third insulating film (8) having a bottom comprising said second insulating film (6); and forming a copper alloy (9) in said groove, wherein said step of forming said groove (7) comprises etching through said second insulating film (6) to expose said first insulating film (5) while leaving a remaining second portion of said second insulating film (6); removing a third portion of said first insulating film (5) to expose said substrate (2) while leaving a remaining fourth portion of said first insulating film (5) (column 2, line 67 – column 4, line 35).

Chow et al. fail to teach controlling the deposition of copper to avoid the formation of a native oxide. However, Koerner et al. (Fig.3) in a related method to form copper interconnects teach controlling the deposition of a copper layer (22) to avoid formation of a native oxide (column 9, lines 13-20). Therefore, it would have been obvious to one of ordinary skill in the art at the time of the invention was made to control

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the deposition of copper to avoid the formation of native oxides as taught by Koerner et al. in the interconnect formation method of Chow et al., since by preventing the formation of oxides, the contact resistance would be reduced and the adhesion of the individual layers would be improved (column 3, line 56 – column 4, line 10).

Response to Arguments

5. Applicant's arguments with respect to claims 29 and 40 have been considered but are moot in view of the new ground(s) of rejection.

Conclusion

6. Papers related to this application may be submitted directly to Art Unit 2823 by facsimile transmission. Papers should be faxed to Art Unit 2823 via the Art Unit 2823 Fax Center located in Crystal Plaza 4, room 3C23. The faxing of such papers must conform to the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2823 Fax Center number is **(703) 305-3432**. The Art Unit 2823 Fax Center is to be used only for papers related to Art Unit 2823 applications.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to **Julio J. Maldonado** at **(703) 306-0098** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by e-mail via julio.maldonado@uspto.gov. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy, can be reached on (703) 308-4918.

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Any inquiry of a general nature or relating to the status of this application should be directed to the **Group 2800 Receptionist** at **(703) 308-0956**.

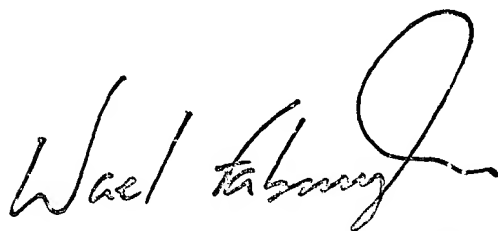
Julio J. Maldonado

Patent Examiner

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703-306-0098

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A handwritten signature in black ink, appearing to read "Wael Tabany". The signature is fluid and cursive, with a large loop at the end.

SUPERVISORY PRIMARY EXAMINER
TECHNOLOGY CENTER 2800